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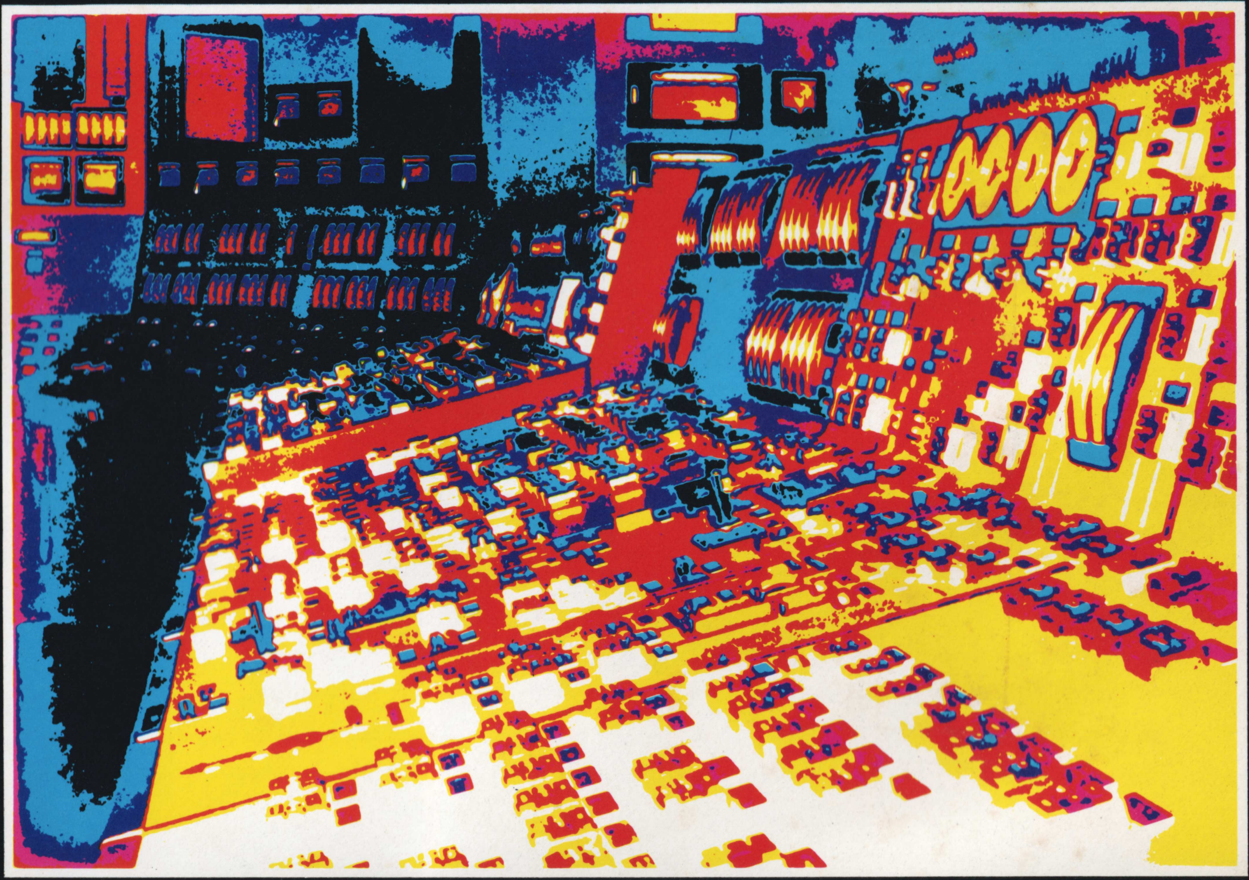
Link Power Plant Simulation Systems by Singer



Today power shortages are a universal concern . . . a challenge to both governments and industry throughout the world.

Increased power demands coupled with fuel shortages have created an energy crisis. Conservation with ecological overtones is the major concern of electric utilities.

Foremost among the forces attempting to alleviate this problem is the Link Division of the Singer Company—the world's leading producer of power plant simulation training systems.

No matter what the energy source—fossil, nuclear, or solar—Link is deeply involved. For example, Link has simulated fossil fuel, boiling water reactor and pressurized water reactor plants. It is the unchallenged leader in power plant simulation technology having designed and produced more such training systems than all other organizations combined.

Link has completed in-depth studies necessary to design and develop a training simulator for the high-temperature, gas-cooled reactor (HTGR). It also has a contract awarded by the U.S. Energy Research and Development Administration (ERDA) to develop plant subsystem and overall plant performance simulation models for a ten megawatt solar thermal power pilot plant. These solar power plant models are based on three different power plant design approaches. ERDA will use these simulation models to evaluate competitive plant and subsystem designs.

The unrivaled experience of Link in the highly specialized technology of simulation for training spans almost 50 years. *Link** trainers have become almost synonymous with flight simulators. The expertise gained in these pioneering efforts—and refined over the years in meeting the complex technical training needs of airlines, armies, air forces and navies throughout the world—has equipped Link to meet one of its greatest challenges to date: the application of simulator technology in pace with the continuing sophistication of power plant control developments.

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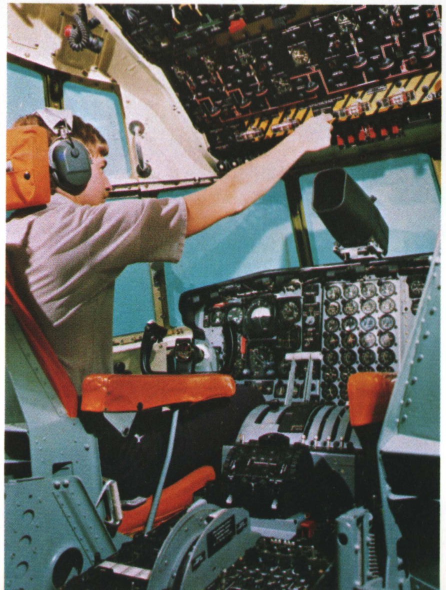
Training by Simulation

Simulation is accomplished by creating realistic replicas of sophisticated systems — such as aircraft cockpits, process plant control rooms or power plant control rooms.

The primary objective of simulation training is to impart specific skills to a trainee. The simulator provides information related to a specific training task through a combination of cues perceived by the senses: visual, aural and kinesthetic. This information—furnished in a realistic setting—helps achieve the proper trainee reaction. He learns to respond in the right way, quickly, effortlessly—almost automatically.

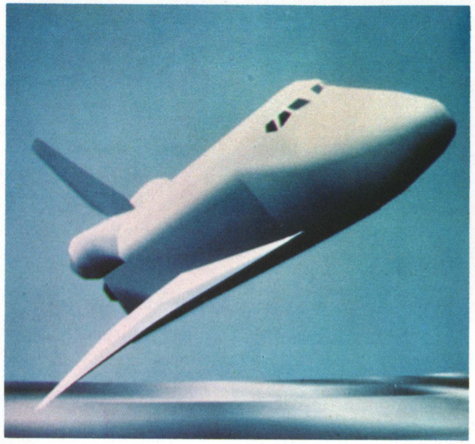
The simulator provides the trainee with an effective way to rehearse actions already learned in theory and demanded of him in actual work situations. The trainee is offered a unique opportunity to interact with controls and instruments, and evaluate the results of his performance.

Petrochemical and oil refinery training simulator console



KC-130F simulator, USMC

Power plant simulator CRT instructor station



Space Shuttle digital image visual system, NASA

Undergraduate pilot training simulator, USAF

Power Plant Simulation

Simulation has proven essential to effective power plant operator training. Each *Link** power plant simulator is an exact replica of an actual plant control room—complete with all functional controls and instruments.

The heart of the simulation system is a large-scale computer featuring high-speed, parallel processing for real-time response activity. Programmed with precise mathematical models of plant operating parameters, the computer accurately simulates plant equipment, including physical, electrical, thermodynamic and aural effects.

The simulator's control room not only resembles an actual operational control room but also responds precisely like one. All metering, alarms and trip responses are displayed exactly as they appear under actual working conditions.

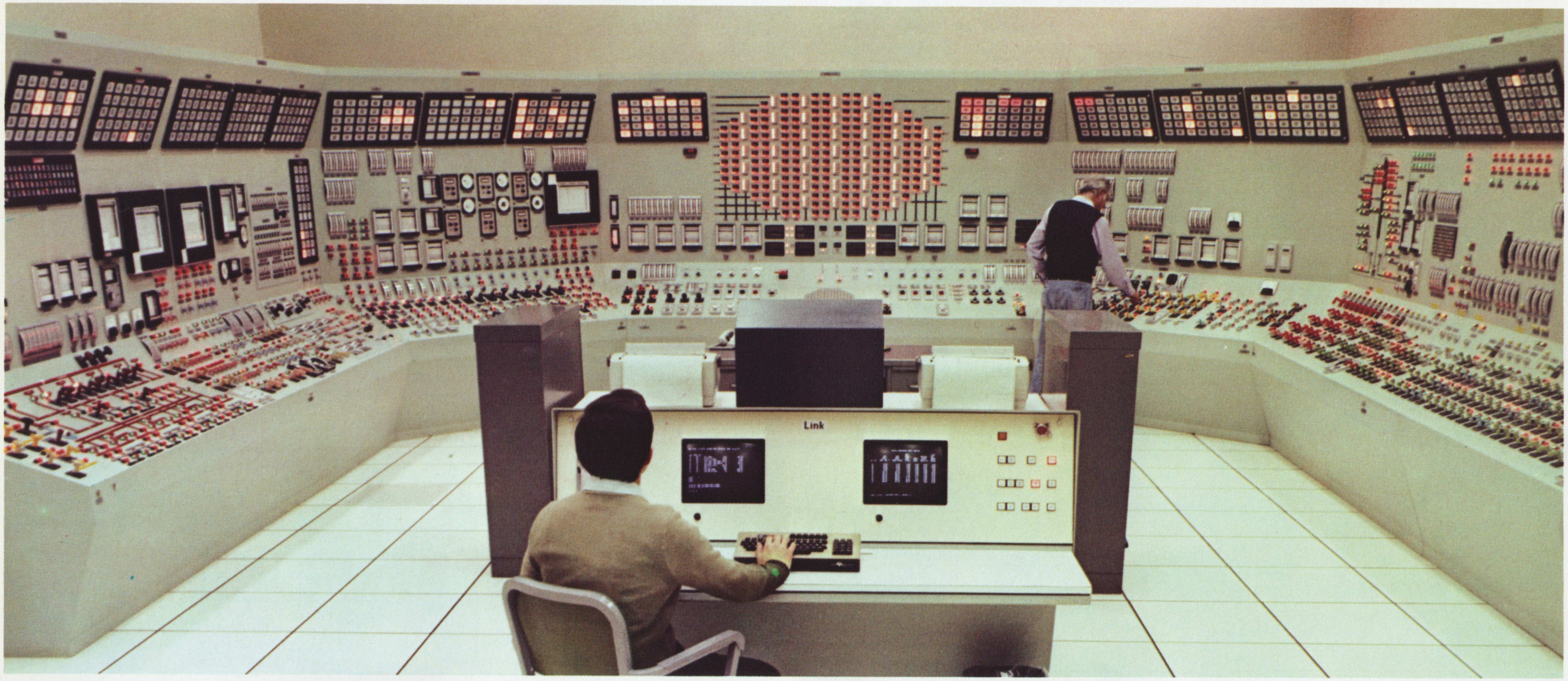
Simulation includes:
- ☐ Hot and cold starts
- ☐ Normal operations
- ☐ Complete or partial shutdowns
- ☐ Various malfunctions
- ☐ Emergency drills

At the start of an exercise, the instructor can establish any one of several initial conditions. The simulator will then reproduce actual plant behavior for the full range of operating conditions.

The computer is capable of stopping or "freezing" the simulation exercise at any point, permitting intensive static examinations of trainee actions. An "instant replay" from the point of freeze permits a review of the proper or improper trainee reaction.

Operation of the simulator is controlled from the instructor console. The instructor can set plant conditions, control power demand, insert malfunctions and monitor trainees' performance. He can, at any time, freeze all plant variables for study and then resume simulation activities at the point of interruption.

The instructor controls and monitors the exercise through a master terminal keyboard and cathode-ray-tube (CRT) monitor. Through this console he can communicate with the computer, updating programs when necessary to make minor changes in system operation or to add malfunctions other than those already programmed.



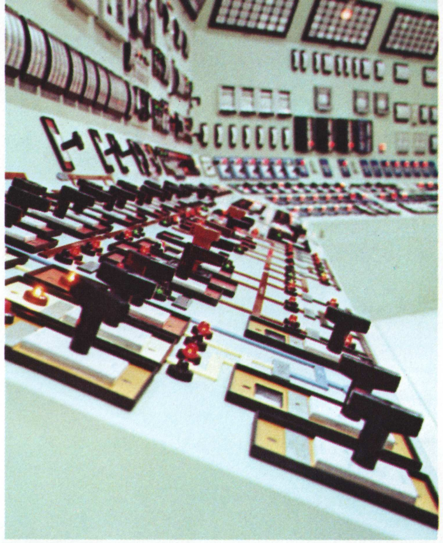
A teleprinter provides a hard copy printout of all operations for meaningful critique, trainee evaluation and progress records.

Recent advancements in CRT technology and electronic miniaturization have enabled Link to redesign the instructor station so that simulator training sessions are even more effective than previously. These new human-engineered instructor stations employ color CRT's to control the simulation process and monitor trainee performance. The instructor can now concentrate on the trainee through these multiple CRT displays instead of being distracted with time-consuming look-up tables and written instructions.

The use of advanced CRT technology in the instructor station complements the latest state-of-the-art power plant control room design, where the CRT's are used to display both alphanumeric and dynamic graphic data to plant operators. This minimizes operator translation and interpretation. CRT formats duplicate the layout of actual plant systems. Critical data is color-coded for immediate recognition and operator response. The instructor views these same displays at his console, an aid in performance evaluation.

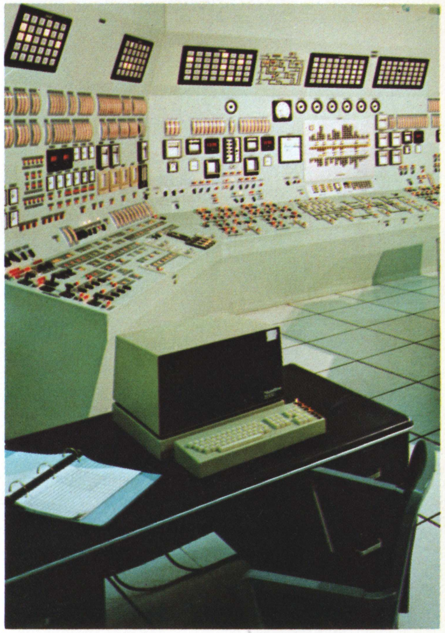
Link power plant simulators are designed and built with one objective in mind: to produce a power plant operator with finely honed skills for the electric utilities, in the most cost effective and efficient manner.

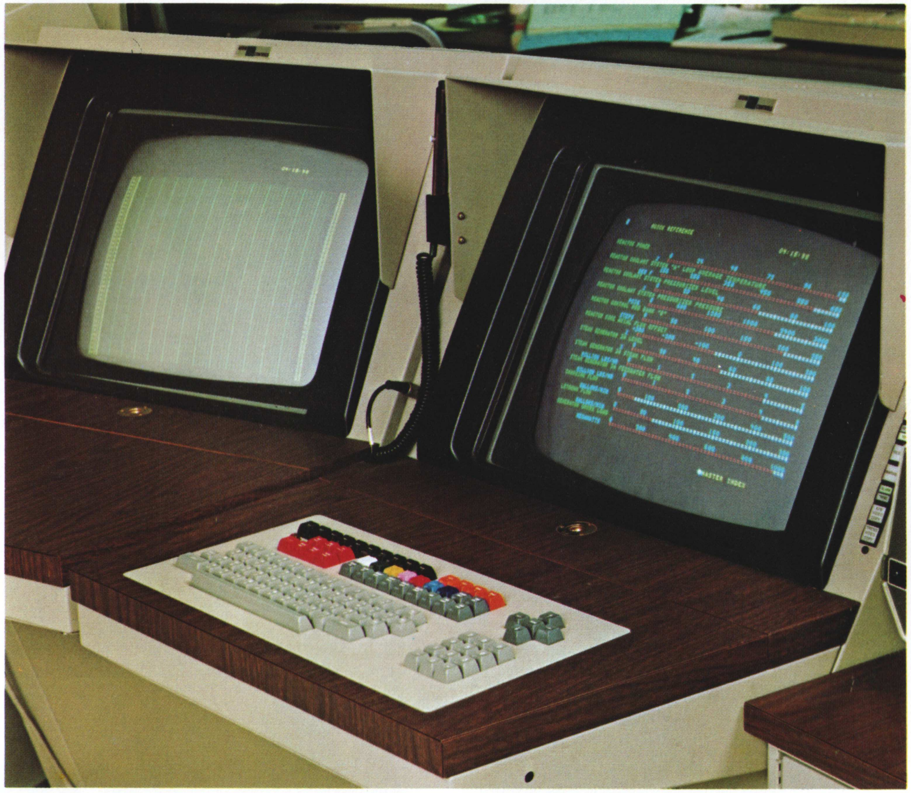
Moreover, these power plant simulators are reliable, achieving phenomenal availability scores.



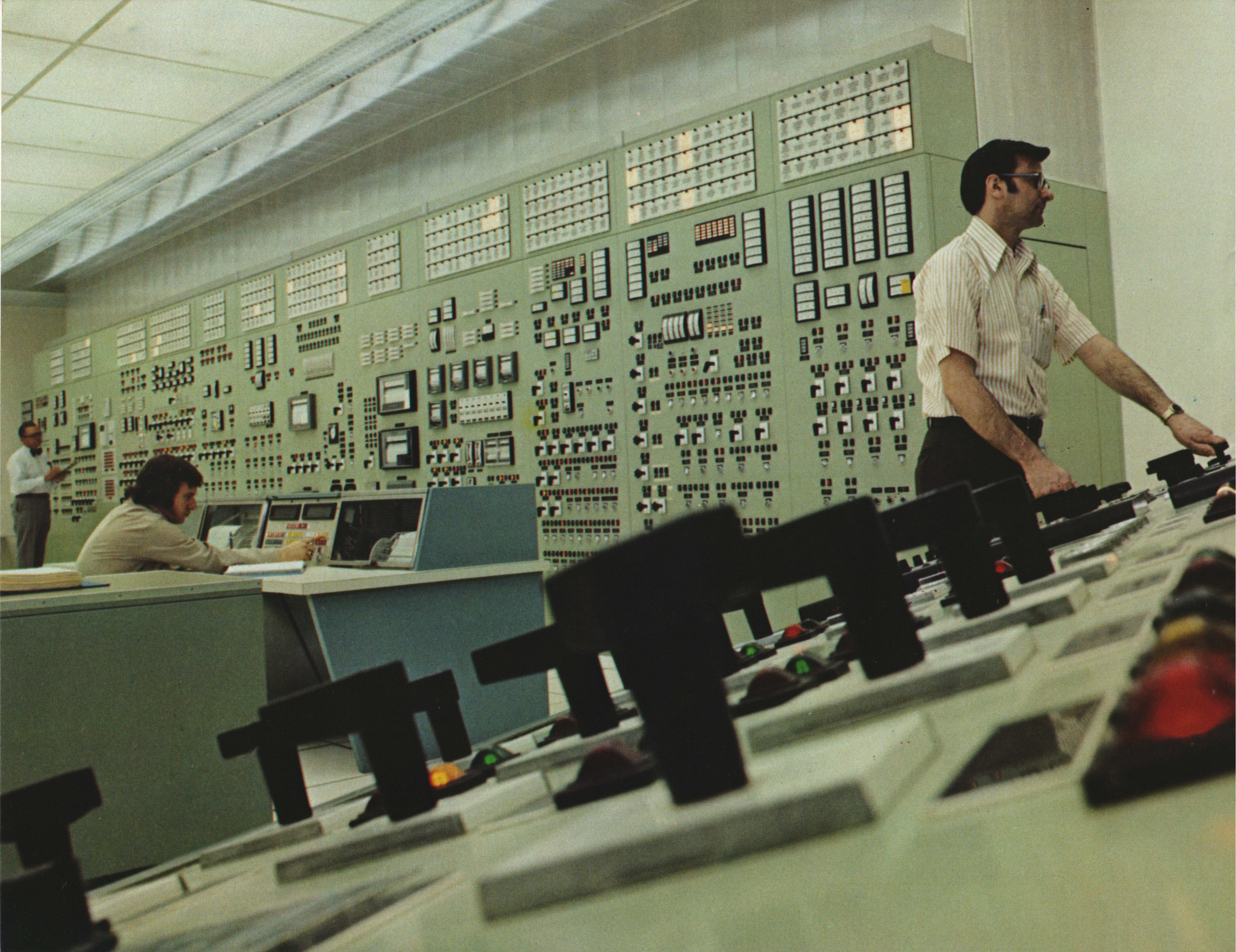
Tennessee Valley Authority uses Link power plant simulators, including BWR based on Brown's Ferry Plant.

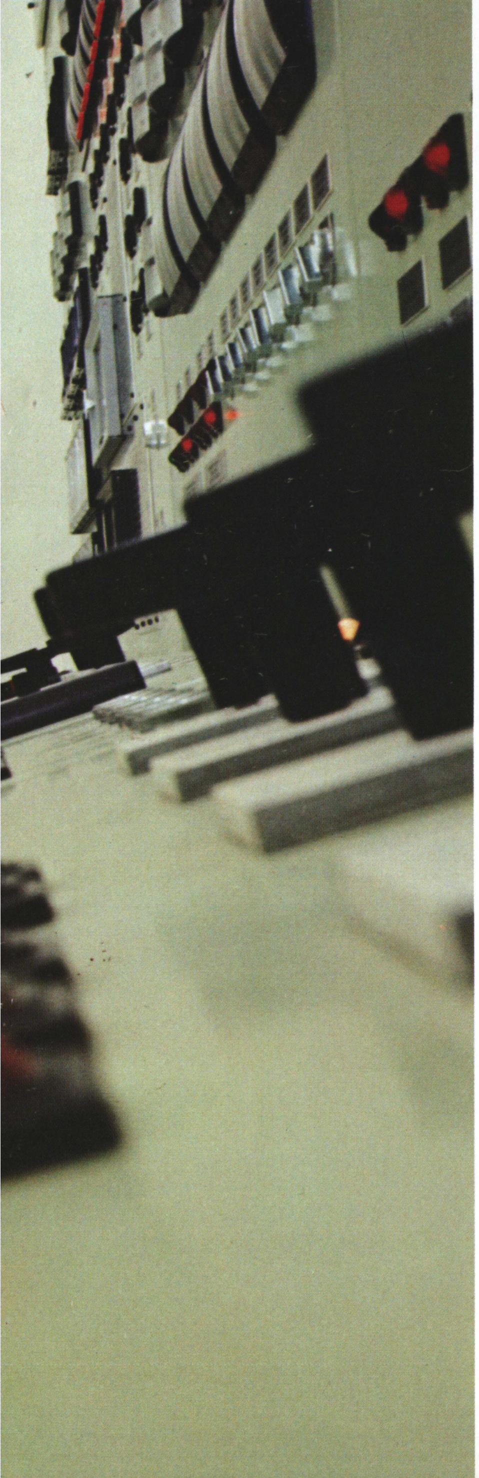
TVA's fossil simulator duplicates a Babcock and Wilcox plant, Cumberland Unit #1—world's largest 1300 MW per unit at full load.





Instructor station of Carolina Power and Light's simulator is equipped with three color 19-inch CRT's: one displays alphanumerics, one graphics; third (not shown) is for mobile instructor use.





Consolidated Edison's Indian Point simulator during first 18 months achieved training availability of 99.5%.

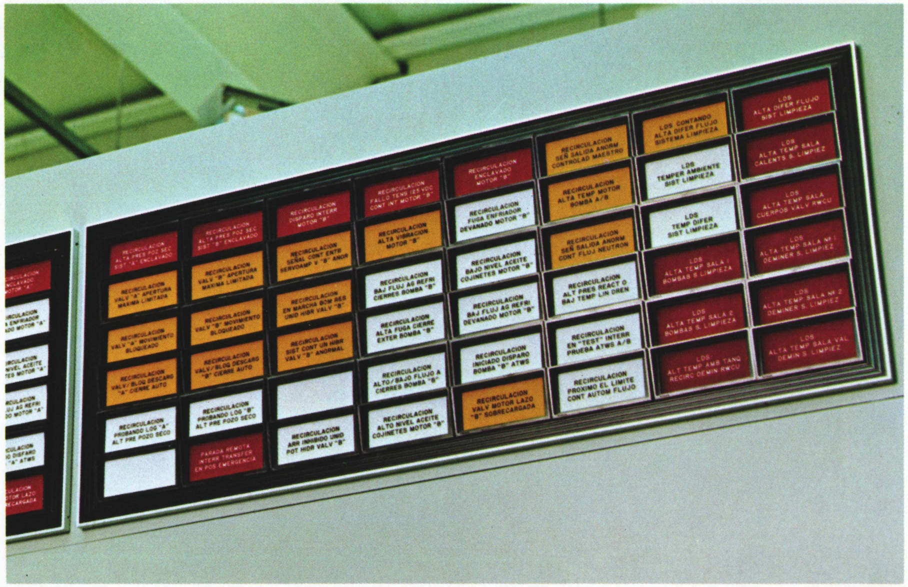
Advantages of Power Plant Simulation Training

☐ Economy

With today's energy requirements, no one can afford to use actual power plants as training centers. Both nuclear and fossil-fueled plants represent a huge capital investment. They must be utilized to the utmost. To employ them as training centers is economically unfeasible.

While the simulator itself represents a substantial investment, its cost justification becomes readily apparent as operational and fuel costs continue to spiral. Several factors weigh heavily in favor of investing in a full scale *Link* power plant simulator:

- ☐ Verifiable operator efficiency in plant operation
- ☐ Fuel savings realized from more efficient operation by better trained operators
- ☐ Prevention of costly downtime due to operator error
- ☐ New plants on-line sooner with fully trained staff familiar with plant operation before actual start-up
- ☐ Substantial savings realized by not sending trainees off-site for initial and requalification training.

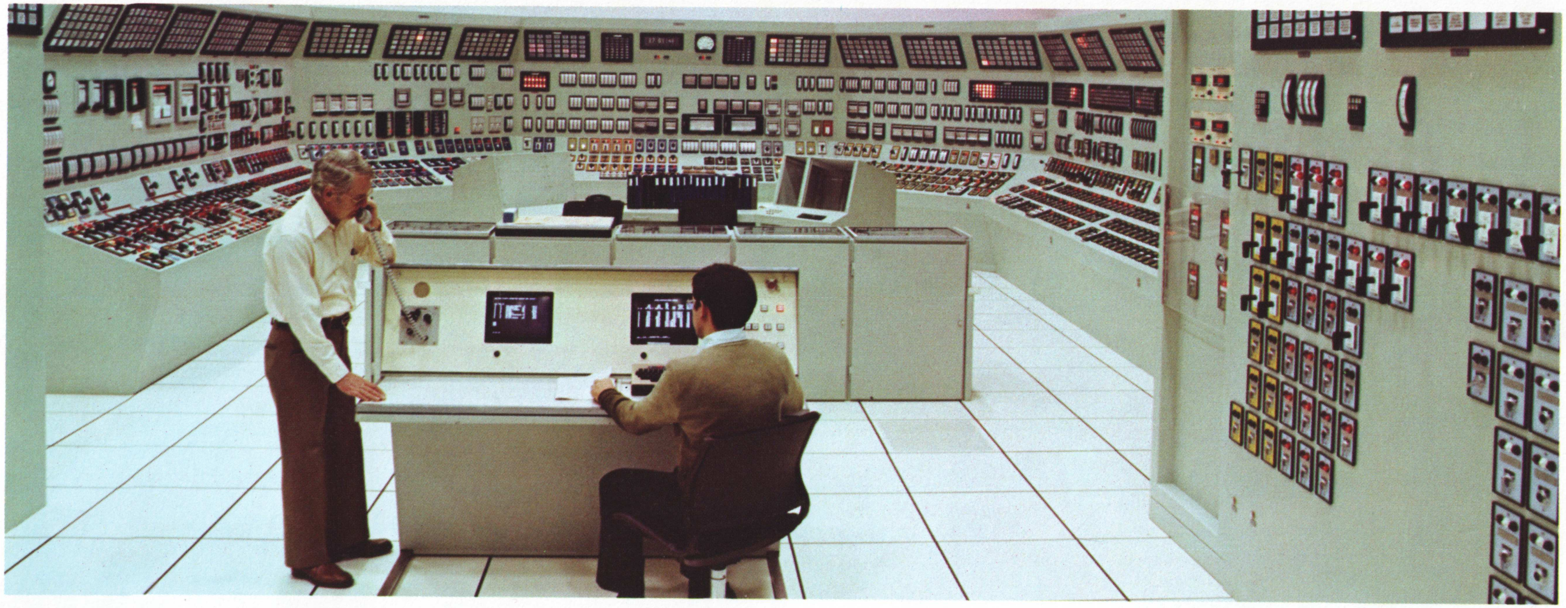


Annunciator panel of BWR simulator for Tecnatom, utilities-sponsored training center in Spain, informs operator of unusual conditions.

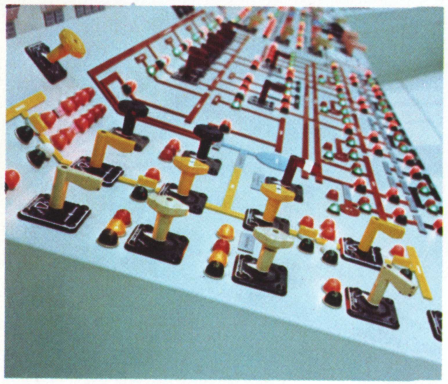
Plant downtime can run as high as $800,000 per day for a large power plant. Off-site training, in which a simulator built for a different plant is used, is costly and may be difficult to schedule. It is also of limited value for requalification and replacement training programs. In light of these costs which show no sign of diminishing, it makes more and more sense to own a *Link** full-scope power plant simulator which simulates the plant in which the trainees will actually be functioning as operators and supervisors. Simulators—as many utilities have already discovered—begin to pay their own way very soon.

☐ Conservation

Conservation measures are urged by government, industry and utilities themselves. Simulation training makes a major contribution toward achieving this top-priority objective.



Sequoyah plant simulator at Tennessee Valley Training Center



☐ More Effective Training

The control room of an actual power plant makes for an ineffective training atmosphere. Operator training is limited to on-the-job observation or limited participation in normal base-load operation. Exposure to abnormal or emergency situations is minimal. Such occurrences are rare and usually handled by senior operators. Experienced operators have difficulty maintaining their proficiency under these routine conditions. Hot or cold starts must be limited to rare mandated shutdowns.

With a *Link** simulator, however, trainees gain operating experience in normal, abnornal and emergency procedures. Experienced operators maintain proficiency. On the simulator all can be exposed to malfunctions which may occur only once in a lifetime of operations. Everyone is prepared for virtually any eventuality.

☐ Flexibility

The instructor can set any plant conditions dictated by the curriculum, freeze dynamic action in mid-mistake and replay the exercise to emphasize certain points in the lesson.

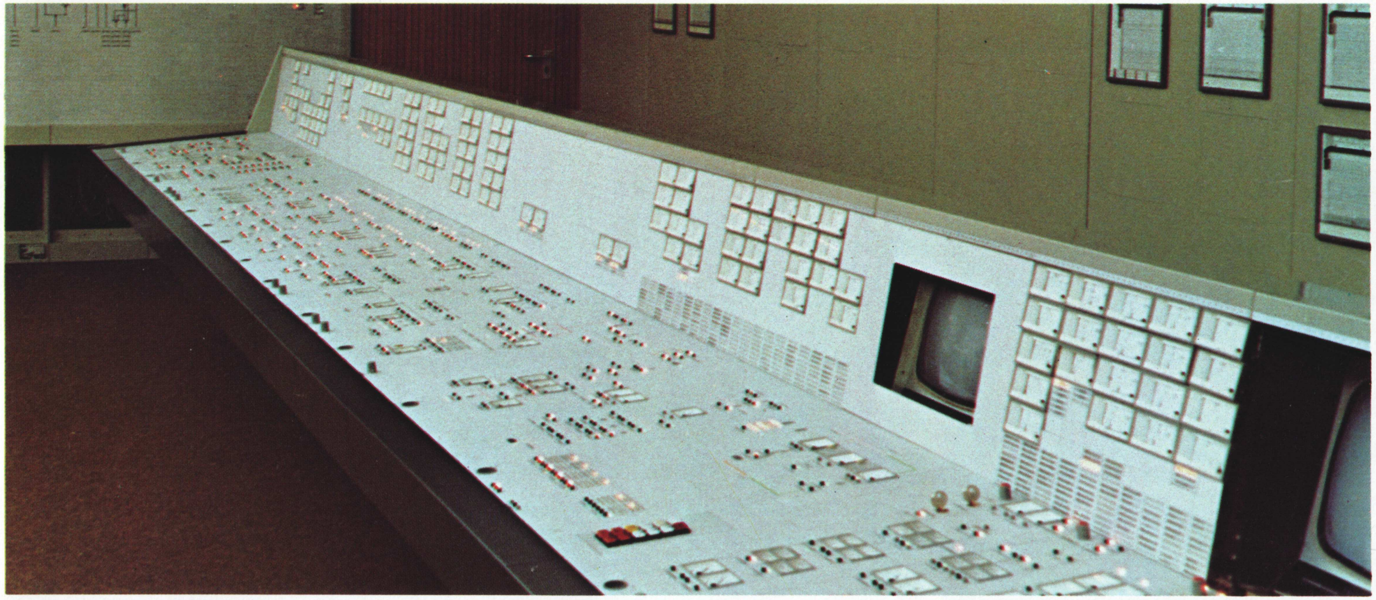
Link power plant simulators are designed with built-in flexibility and expandibility to meet future operator training requirements. As modifications are added to the actual plant, they can be included in the simulator program too.

☐ Safety

Because a simulator-trained operator has been totally involved with his job before stepping into an actual control room, he runs a much safer plant. He has been exposed to every possible emergency and has reacted properly. The trainee is taught how to cope with more critical situations on the simulator than most operators experience throughout their career.

☐ Convenience

A trainee on the simulator can learn both hot and cold starts without shutting down a plant or waiting for rare scheduled shutdowns. Training sessions can be held any time—without costly power interruptions.



This simulator is installed in Kraftwerksschule's training center for use by German PWR operators.

☐ Licensing—NRC

Where regulatory agencies—such as the Nuclear Regulatory Commission in the U.S.—require licensing of power plant operators, simulation is accepted for the fulfillment of preliminary requirements for the examination as well as the conduct of the examination itself.

Most of the NRC's stringent nuclear plant operator experience requirements can now be met on the simulator. The Commission grants three months operational credit for each month spent on the simulator during the initial training period. Under recently proposed rules for requalification of licensed operators, the NRC strongly recommends simulator usage to fulfill these requirements.

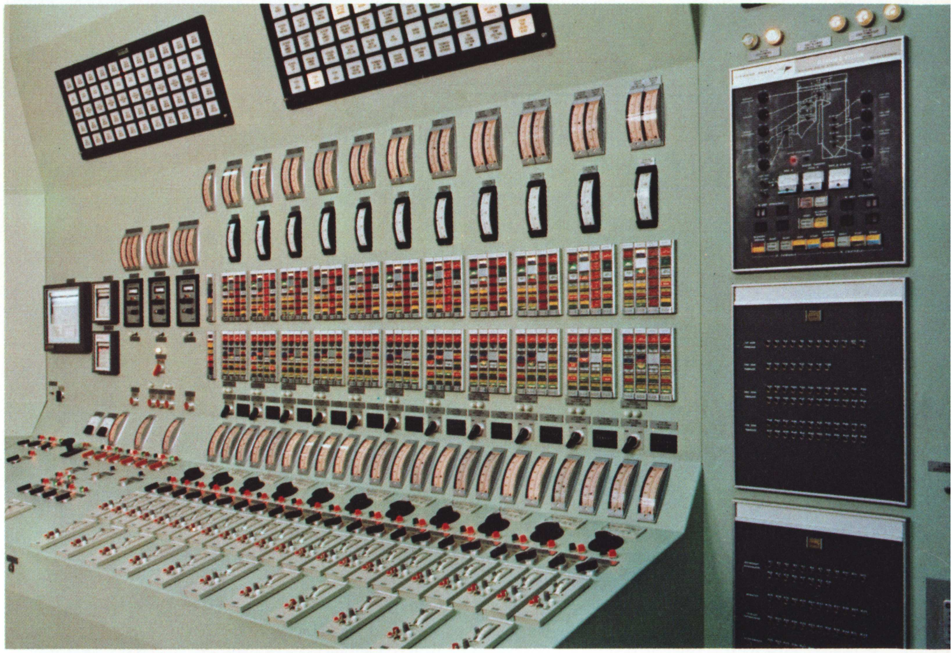
☐ Operator Confidence

A simulator-trained operator faced with sudden critical situations is more likely to handle them with confidence since he has encountered these problems before on the simulator. Moreover, on the simulator the operator is given the opportunity to demonstrate his knowledge and skills. This increases his desire for more knowledge and motivates him to work out problems and procedures on the simulator.

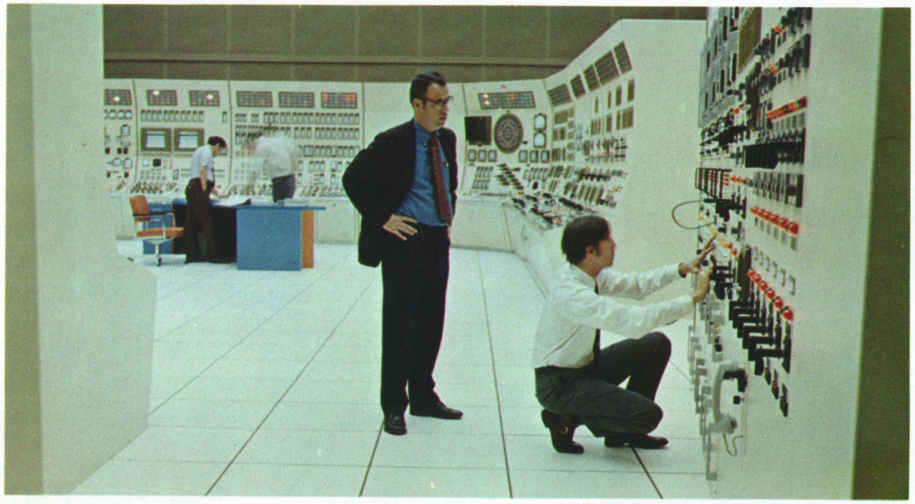
☐ Trainee Evaluation

*Link** simulators are equipped with a hard-copy printout capability. A trainee's performance is documented for later critique and evaluation. A complete record of his progress can be kept in a log.

Training capability of this fossil simulator includes coal-pulverizing, whose panel is shown here, automated boiler control system and Diamond Power soot blower system.



Combustion Engineering's PWR simulator uses computer, math model and instrumentation—all designed by Link.

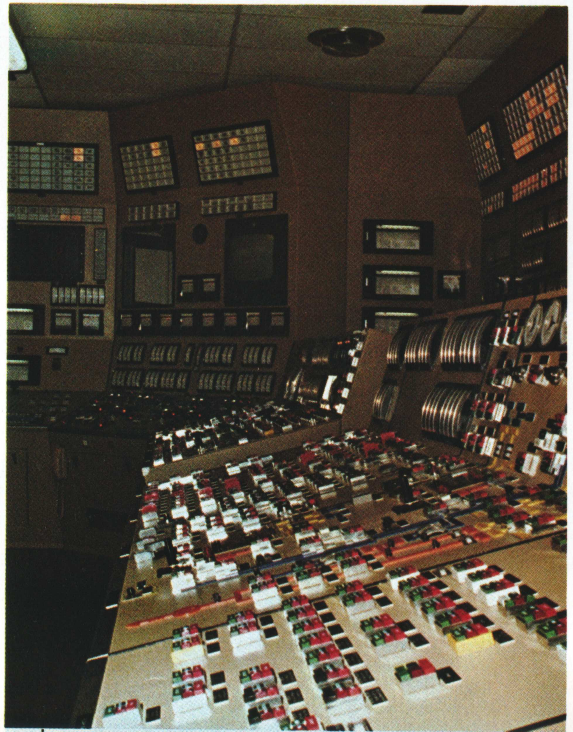


Summary

In short, it makes good economic sense to train power plant operators with an on-site *Link* simulator.

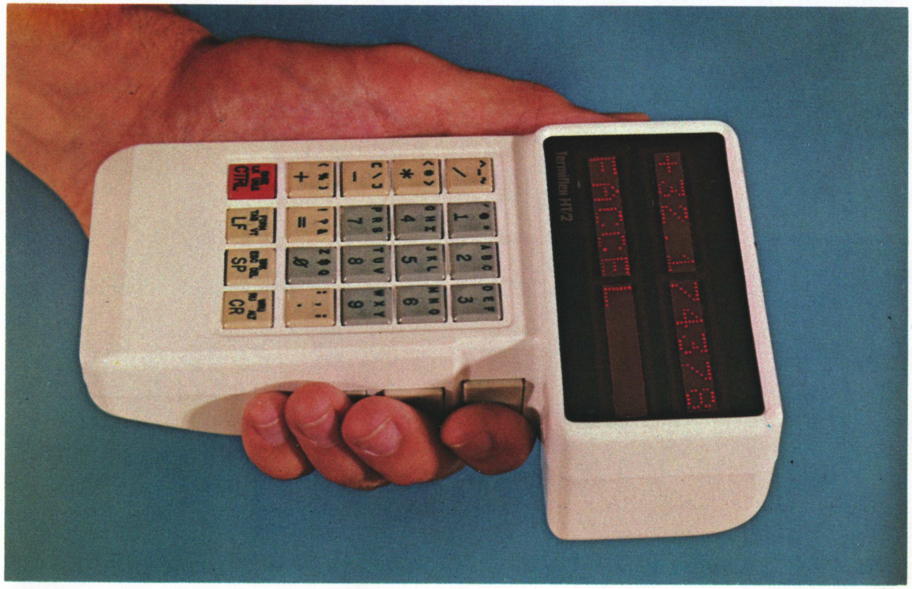
All types of training can be offered: initial, replacement and requalification training. In-depth training of present personnel can be accomplished even before actual plant completion. An on-site simulator can also assist in development of procedures specifically tailored to the plant simulated. Training schedules are vastly simplified, eliminating extensive delays and waiting periods experienced with off-site simulators.

An on-site training center—equipped with a *Link** full-scope simulator—has proven to be the most cost-effective method of providing training missions structured to meet the most stringent requirements.



Duke Power's PWR simulator features 19-inch color CRT alphanumeric display with graphic repeater.

Hand-held Termiflex™ remote control device enables instructor to move freely about, observing trainee while directing simulator operation as he would from instructor console.



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Total Simulation Capability

The Link Division of the Singer Company consists of an integrated team of experienced professionals who have made significant contributions to the advancement of training technology.

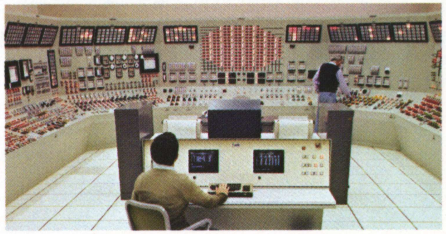
Link has over 200 engineers and scientists working on power plant simulation at the Silver Spring Operations in Maryland. Simulation is Link's business—its only business—not a sideline.

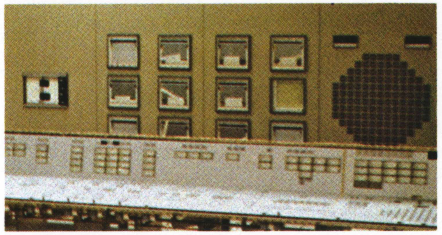
No one else has such a broad base of experienced power plant technology. This technology has made Link the leader in the scope of software development, in the versatility of simulator computers, in state-of-the-art instructor stations, in math modeling, in program reviewing and in worldwide servicing.

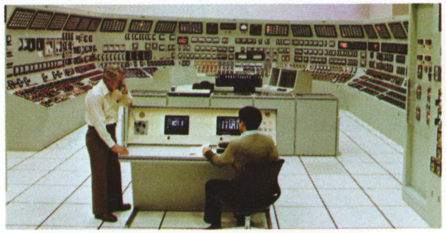
Since Link contracted for its first power plant simulator in July 1968, it has designed, built and delivered more full-scope simulators than all other suppliers combined.

Link has delivered or is building simulators for:

- ☐ Babcock and Wilcox (PWR)
- ☐ Carolina Power and Light (PWR)
- ☐ Combustion Engineering (PWR)
- ☐ Consolidated Edison (PWR)
- ☐ Duke Power Company (PWR)
- ☐ General Electric—Taiwan Power Company (BWR)
- ☐ Kraftwerk Union (PWR)
- ☐ Kraftwerksschule—Germany (BWR, PWR)
- ☐ Pennsylvania Power and Light (BWR) with Advanced Control Room
- ☐ Tecnatom—Spain (BWR, PWR)
- ☐ Tennessee Valley Authority (BWR, Fossil, PWR)
- ☐ Washington Public Power Supply System (PWR)







For more information on power plant simulators contact:

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